the open sea, bound for Puget Sound. The weather did not seem as warm when we reached the outside, and I do not remember exactly its temperature; but it was not nearly as cold as when we were on the way up, in January.

THE "DRY" CHINOOK IN BRITISH COLUMBIA.

By R. T. Grassham. Dated Keithley Creek, B. C., March 5, 1907.

I am living at a stock ranch in the Bonaparte Valley—which lies about midway between the Cascade and Gold Ranges and the Rocky Mountains—north of Ashcroft, on the line of the Canadian Pacific Railway.[1] Our district is known as the "dry belt". Very little or no rain falls during the spring or summer. We depend upon irrigation for our crops and hay, and my experience of the chinook is as follows:

After having a cold snap of zero weather, with a foot of snow on the flats and hillsides—bright clear weather—there comes a change; heavy dark clouds loom up from the west and southwest, accompanied by a very strong wind—at times one might call it a gale. No matter what the temperature previous to this change (40° below zero, or anything), within a few minutes the air becomes balmy as spring—by contrast it seems hot. I have known the thermometer to rise 59° in five minutes. When we have this wind, one can read in the daily papers of shipping disasters and storms off the Vancouver Island and Washington coasts. Heavy rain and snow [occur] west of the Cascade Mountains, but I find no account of the temperature being so high west of the Cascade Mountains as with us.

As to the dryness, our house lies in the valley. The Cariboo wagon road is some feet above the house, and the ground rises at an angle of 30° to the first hill, then in a series of benches to timber. The curious phenomenon [may be noted] of having one foot of snow as it were *sucked* up from off the ground (the ground being frozen to the depth of several inches). In three or four hours not a vestige of snow may remain, and yet not a trickle of water crosses the road. As the ground is frozen, therefore the idea of absorption in the ground is untenable; the water does not run off.

Is not the air heated by friction, so that the intense dryness of the wind evaporates and absorbs the moisture?

We never have a chinook in winter accompanied by clear weather, but always dark, stormy-looking clouds, and they rarely last more than three days.

We are much interested in these same chinook winds. This winter I have been at Keithley Creek managing an estate. On the flat the snow was 5 feet deep; on the Bonaparte the snow was 18 inches to 2 feet deep; and all cattle had to be fed—a serious item with a big band of cattle. Usually we need only to feed range cattle once in seven years, our fenced-up winter pastures being fully sufficient, except for a few sick cattle. So when we have a heavy fall of snow and zero weather our sole ambition is for a chinook; and there is no doubt whatever when it does come—we never forget the accompanying atmospheric conditions with us at the ranch, or on the seacoast.

* * * * * * *

As a rule the barometer drops when strong winds and rain are coming. Is this because of the denseness of atmospheric pressure, accompanied by the dampness or moisture in the atmosphere?

Do you think the barometer will act the same with a gale of wind accompanied by heavy rain, as with a gale accompanied by the heat of a chinook when a dry atmosphere absorbs the moisture from the snow on the flats and steep hillsides with practically no waste?

THE WET AND DRY CHINOOKS.

The following abstract of correspondence on this subject may interest many teachers and observers:

[1] This description places him in latitude 52° 45′ N., longitude 121° 45′ W., approximately.—Editor.

To the best of my knowledge, the name "chinook" is applied to two very different sorts of winds. I believe it was originally applied to a warm, moist southwest wind at stations near the coasts of Oregon, Washington, and British Columbia, which was supposed to blow from the region where the Chinook Indians lived, or to be in some other way associated with them. Quite independently of this use of the word, it was applied by settlers in the west of Montana to a warm, dry wind descending the Rocky Mountain slope. Some thought that it blew from the chinook region of the Pacific coast, others simply said that it was as warm as the chinook winds of the Pacific coast. However, in some way this application of the name to a warm, dry wind descending the mountain in clear weather has become so general that its original application to a moist, southwest wind has been almost lost sight of.

The discussion in reference to the winds of December 22, 1906, hinges upon the definition of a chinook wind. If it means the wet chinook of the coast of British Columbia, then its temperature and moisture are due to the fact that it has just arrived from the Pacific Ocean, laden with moisture which is condensed into cloud and rain as the wind rises over the coast ranges. The Japan current is too far to the west to have any particular influence on either temperature or moisture. On that particular date, December 22, an area of low pressure was west of Vancouver Island, and, whatever the local winds may have been, there must have been a general movement of the atmosphere from the Pacific west of Oregon northeastward toward British Columbia, and this would of itself bring warm, moist air enough to explain a rise of temperature from 12° F. at 8 a. m. to 43° F. at noon (of the one-hundred and twentieth meridian); in fact this southwest wind blows outward from a great area of high pressure central near the Hawaiian Islands, so that its temperatures come from the Tropics, and not from the Japan current. The influence of the Japan current has been exaggerated in popular estimation by many thoughtless writers as much as the influence of the Gulf Stream on the Atlantic Ocean.

A second alternative explanation has been suggested, namely, that the strong southwest gale from the ocean, blocked in its passage over the mountains, rises and precipitates its moisture as rain or snow; then "the wind being lighter as it ascends higher, with increased velocity, continues eastward, and on the eastern slope descends to the valley with such rapidity that the friction warms it up to the recorded temperature".

This proposed explanation seems to be entirely inadmissible if it is intended to apply to Keithley Creek. I do not see how a southwest gale from the Pacific can be said to have past over a mountain range and descend on the eastern slope to this station, which is located on a small stream flowing out of Cariboo Lake into the Frazer River. A westerly wind will blow up the stream from the ocean and an easterly wind down stream from the neighboring hills and the Rocky Mountains. In addition to these geographical objections to this explanation there is a very important meteorological consideration. A wind is not warmed up by friction as it blows over the ground. If the ground is hot and dry it may receive heat by conduction, but if the ground is damp the moisture will evaporate and the wind will be cooled by that process. A "wind that descends to the valley with rapidity" is not warmed up by friction, but by the compression due to the increasing barometric pressure. When air rises it cools by reason of the work done by expansion, as it comes under lower pressure, precisely as steam escaping from a boiler cools by expansion. On the other hand when air descends it comes under greater pressure, and is comprest and warmed by reason of the work done in compressing it. This warming by compression is to be observed whenever air is comprest by machinery; as, for example, in pumping air into the tire of a bicycle. In such compression, if no moisture is added to the air, then the simple increase in temperature makes the air become relatively drier; or we may say that its relative humidity is diminished, or its capacity for moisture is increased. If the air is slightly foggy at first, then the fog disappears as soon as it is slightly comprest and warmed; consequently a descending, warm, chinook wind is also a dry wind with cloudless sky. In this process we have the natural explanation of the dry chinooks of Montana, and also of similar chinooks when they occur in British Columbia. These dry chinooks frequently occur in California, and I do not see why they might not occasionally occur at Keithley Creek; but in this case they should be easterly or northerly winds descending the Rocky Mountain slope. They would not necessarily be very warm, but would be very dry. Thus in California the cold, dry, descending northeast wind, by reason of its causing rapid evaporation, and by reason of the clear sky and danger from frosts, is liable to do great damage to the delicate vegetation.—*C. A.*

The behavior of the barometer is very different in the dry and the wet chinooks. The latter is a moist southwest wind on the east side of an advancing area of low pressure, and the local barometer falls as the low area approaches. Then there follows the strong, dry northwest wind and the rising barometer on the west side of the low area. These winds are called horizontal, because their average inclination toward the ground is slight, and the cooling by expansion or warming by compression is correspondingly slight; it also proceeds very slowly and is not prominent to the observer.

In the dry chinook the slope of the descent and ascent is great, and the warming is rapid and prominent; the rise or fall of the barometer is not a prominent feature of the dry chinook, which wind is essentially due to an overturning of the upper and lower layers of air when they are in unstable equilibrium; the dry chinook occurs with equal ease either with southwest winds and falling barometer, or northwest winds and rising barometer, depending on the location of the mountains relative to the station.

The low pressure in the great low areas is not due to the temperature, moisture, or density of the air, but is the mechanical result of the wind, like the whirlpools, vortices, or eddies in rapid rivers, or those made artificially in a basin of water. The large barometric gradient shown by the isobars on our daily maps is not that slight gradient which causes the wind, but is itself essentially produced by the action of the wind.—*C. A.*

THE HURRICANE OF 1867 IN THE BAHAMAS.

Mr. Maxwell Hall calls attention to the fact that the great Bahama hurricane of October 1, 1867, which was partially studied by Buchan (see p. 265 of his "Handybook"), is worthy of a more elaborate study. The material for such a study probably still exists in the archives of the hydrographic offices of France, Germany, England, and America, to say nothing of the observations at land stations, which are preserved in the archives of the meteorological offices of those same nations. Some reliable accounts will also undoubtedly be found in the newspapers and journals for that year. The compilation of these data and the preparation of the charts of isobars and winds would form a very appropriate subject for a thesis for a graduate degree. Such subjects are of great meteorological interest, as well as commercial importance.

During the month of June, 1867, the writer happened to have charge of the library and archives of the Hydrographic Office, U. S. Navy, which had just been removed from the Naval Observatory and was temporarily established in what is known as the "Octagon Building", corner of New York avenue and Eighteenth street. He well remembers the immense collection of log books from vessels of every nationality that had been accumulated by Commodore Maury for use in his enthusiastic researches on the meteorology of the ocean, and his compilation of general sailing charts, to which the modern pilot chart is a worthy successor. The whole series of charts published by him is rare and difficult to obtain. Perhaps very few realize that it included six different series, known by letters, as follows:

Series A. Track charts.
Series B. Trade wind charts.
Series C. Pilot charts.
Series D. Thermal charts.
Series E. Storm and rain charts.
Series F. Whale charts.

The whole series comprises at least eighty charts, published between the years 1849 and 1860, under the general title, "Wind and Current Charts".

The more recent charts of winds, pressure, temperature, currents, etc., on the various oceans, as published by the British, French, and German offices; the daily maps of the Atlantic, published by the French and British, and especially the Danish office; and the daily maps of the Northern Hemisphere, published by the U. S. Weather Bureau, show the great advance in our knowledge since 1860.

It would be interesting to publish the numerical statistics of the great mass of manuscripts and logs of vessels now preserved by the various governmental offices for use in the study of the atmosphere over the ocean. The old records of sailing vessels give us the most precious data, and almost all that we have, relative to those parts of the ocean where the modern steamship never goes. Maury began his work just in time to save the old records before they were destroyed as waste paper, and before sailing vessels were replaced by steamers.

In Bulletin No. 113, published by the U. S. Hydrographic Office, in April, 1897, Mr. James Page says that in addition to an indefinite number of rough logs presented by the masters of vessels that office has 380 abstract logs, each containing three months' records, and 85,000 forms 105*a* and 105*b*, containing the simultaneous Greenwich mean noon observations. The total number of complete observations was then estimated at 4,000,000, but by the present date (1907) this number must have been more than doubled.

NOTES FOR TEACHERS.

The December, 1906, number of School Science and Mathematics refers to several matters that may be interesting to teachers of meteorology. On pages 762–768 we have descriptions of several simple pieces of apparatus for determining the percentage of oxygen in the air. These are designed for use in large classes with the least possible expenditure of the teacher's time. Several pieces of apparatus may be kept in constant service for several weeks without requiring any of the teacher's time. Experimental work of this kind is the only way by which to convey instruction vividly and impressively. The scholar never forgets the percentages (by volume), 21 and 79, when he has made a few measurements of this kind with such apparatus.

A special application of apparatus for measuring the oxygen and the aqueous vapor in the ordinary atmosphere consists in applying it, first of all, to the pure air breathed into the lungs, and then to the impure air exhaled from the lungs. Of course in the latter case increased quantities of carbonic acid gas and aqueous vapor are discovered. We are often taught that this carbonic acid gas is produced by the oxidation of carbonaceous material in the blood when brought into contact with the warm air of the lungs; if this be true then the ratio of the oxygen to the nitrogen in the exhaled air should be less than the $\frac{21}{79}$ of the inhaled air. Possibly the student will be surprised to find that it is not so, and that he has been wrongly taught.

On page 772 is an interesting article by R. A. Millikan on "Cooling through change of state", in which a simple experiment shows the changes of temperature that are produced by crystallization from or solution in liquids. He lays especial stress upon the importance of graphs in some cases, but also confesses that, like many others, he has had "difficulty in finding a sufficient number of sensible and natural applications of the graphical method. The graph should be used as the interpreter of the physics, and not the physics as interpreter of the graph".

On page 778 a method of determining the horsepower of a small steam engine, or the work done in a unit of time, could probably be applied to the wind or to an anemometer for determining the work done by the wind.

On page 795 School Science reprints from Scientific American a general description of the use of hydrolith for generating hydrogen. This hydrolith is supposed to be a hydrate of calcium, and if the data given are correct its use would be of great advantage in aerial research. Unfortunately the article omits to state the fact that this chemical is not for sale in the market. Only a few pounds of it have ever been made. An analogous compound is offered for sale in the United States, under a different name, but its future usefulness is still problematical. The great stimulus recently given to ballooning will, however, undoubtedly bring about many chemical and mechanical improvements.—EDITOR.